LA50 IN BURN INJURIES

SURFACE LÉTALE 50% DES PATIENTS BRÛLÉS

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SUMMARY. Burn injuries put a huge financial burden on patients and healthcare systems. They are the 8th leading cause of mortality and the 13th most common cause of morbidity in our country. We used data from our Burn Registry Program to evaluate risk factors for mortality and lethal area fifty percent (LA50) in all burn patients admitted over two years. We used multiple logistic regressions to identify risk factors for mortality. LA50 is a reliable aggregate index for hospital care quality and a good measure for comparing results, also with those of other countries. 28,690 burn patients sought medical attention in the Emergency Department, and 1721 of them were admitted. Male to female ratio was 1,75:1. 514 patients were under 15 years old. Median age was 25 (range: 3 months – 93 years). Overall, probability of death was 8.4%. LA50 was 62.31% (CI 95%: 56.57-70.02) for patients aged 15 and over and 72.52% (CI 95%: 61.01-100) for those under 15. In the final model, we found that Adjusted OR was significant for age, female sex, TBSA and inhalation injury ($P < 0.05$). LA50 values showed that children tolerate more extensive burns. Female sex, burn size, age and inhalation injury were the main risk factors for death. Authorities should pay special attention to these variables, especially in prevention programs, to reduce mortality and improve patient outcome. Children have better outcome than adults given equal burn size. Suicide rates are higher for women than men in our country.

Keywords: lethal area, mortality, risk factors, burns, inhalation injury

RÉSUMÉ. *Les brûlures sont responsables d'une lourde charge financière pour les patients et les systèmes de santé. Elles représentent dans notre pays la 8ème cause de mortalité et la 13ème cause de morbidité. En utilisant les données de 2 ans du programme de surveillance des brûlures, nous avons évalué les facteurs de risque de mortalité (par régression logistique) et la surface létale 50% (SL50). Cette mortalité 50% est un bon indicateur d'efficacité de soins et de comparaison entre centres et pays. Le service d'accueil des urgences a pris en charge 28 690 patients parmi lesquels 1 721 ont été hospitalisés. Le ratio hommes/femmes était de 1,75/1. Cinq cent quatorze patients avaient moins de 15 ans. L'âge médian était de 25 ans (3-93). La mortalité globale était de 8,4%. La SL50 était de 63,31% SCT (CI_{95} 56,57-70,02) au-delà de 15 ans et de 72,52% SCT (CI_{95} 61,01-100) en deçà. Les facteurs de risque de mortalité étaient l'âge, le sexe féminin, la surface brûlée et l'inhalation de fumées, paramètres sur lesquels devraient s'appuyer les campagnes de prévention. Les brûlures volontaires sont, dans notre pays, plus fréquentes chez les femmes que chez les hommes.*

Mots-clés*: brûlés, mortalité, facteurs de risque, inhalation de fumées*

Introduction

In our country, about 100,000 - 150,000 burn patients seek medical attention annually, with about 6% of them admitted to burn hospitals. Mortality of burn patients in our country is about 10%.[1, 2, 3, 4, 5, 6]

Burn mortality depends on the treating centre and severity of the burn. In developed countries, about 1% of patients in Emergency Departments are admitted due to burns.

Mortality rates are about 5-6.5%. Each year, about 200,000 patients around the world die due to burn injuries.[7] Burn injuries are one of the biggest public health concerns across the globe, particularly in developing countries. Southeastern Asia, especially India, and the Middle East have particularly high mortality rates.[7,8] These injuries impose a considerable burden on the healthcare system. For example, in our country it is the 8th leading cause of years of life lost, and the 13th most common cause of disability-adjusted life years (DALY) lost.[9] Therefore it has a huge economic burden on patients, their families, insurance companies and health care systems. Evaluating and identifying potential factors affecting mortality in burn patients may help physicians to better treat the critical cases, and help the authorities in the Ministry of Health to develop measures to prevent burns and burn mortality. We have found several studies on the epidemiology of burns, but there is currently a lack of reliable studies on mortality risk factors.[10]

We conducted this study to identify the major risk factors for mortality in burn patients, while adjusting for other factors by multivariable models. Multivariable models proved to be a better basis for research in this field.[10]

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Table I - Age, sex distribution and causes of burn cases

Age group	Total	Gender		Cause				
		male	female	scald	flame	contact	electrical	chemical
	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
< 5	360 (22.18)	214 (20.56)	146 (25.13)	146 (70.19)	47 (22.60)	3 (1.44)	3 (1.44)	9 (4.33)
5-14	154 (9.49)	104 (9.99)	50 (8.61)	26 (25.49)	64 (62.75)	0	9 (8.82)	3 (2.94)
15-24	272 (16.76)	182 (17.48)	90 (15.49)	7 (3.27)	166 (77.57)	4 (1.87)	33 (15.42)	4 (1.87)
25-34	325 (20.02)	236 (22.67)	89 (15.32)	6 (2.21)	199 (73.16)	7 (2.57)	51 (18.75)	9 (3.31)
35-44	216 (13.31)	143 (13.74)	72 (12.39)	3 (1.67)	148 (82.22)	2 (1.11)	25 (13.89)	2 (1.11)
45-54	132 (8.13)	82 (7.88)	50 (8.61)	12 (11.01)	78 (71.56)	4 (3.67)	14 (12.84)	1 (0.92)
55-64	83 (5.11)	46 (4.42)	37 (6.37)	8 (13.56)	43 (72.88)	3 (5.08)	2 (3.39)	3 (5.08)
65 +	81 (4.99)	34 (3.27)	47 (8.09)	10 (16.39)	38 (62.30)	4 (6.56)	7 (11.48)	2 (3.28)
Total	1623	1041	581					

Materials and methods

The Burn Registry Program in our country started a few years ago. To evaluate and identify mortality risk factors among patients with burns, we used data from two successive years. All patients admitted due to burns during this period were included in our study.

The criteria of the American Burn Association (ABA) were used for burn patient admission. All the data on burn patients were collected through a registration system. Six trained staff were responsible for interviewing the victims or their families and filling in the specially-designed questionnaire. Validity of the data was evaluated by four physicians. The patients were followed from admission to discharge.

All factors that can affect mortality and morbidity were studied, such as age, sex, inhalation injury, the length of time from injury to care, accompanying traumas, previous medical history and illnesses, place of burn, presence or absence of parents for burn children (unsupervised children), anatomic distribution of burns, seasonal variation, cause of burn, total surface area of burns, burns due to explosion, ignition of clothing, mode of extinguishing the fire, extent of 3rd and 4th degree burns, insurance coverage, level of education, type of transportation to hospital, mode of burn (intentional or accidental), previous clinical condition, any treatment for burns at home (pre-hospital treatment), medical staff pre-hospital care, ICU admission and mortality, length of hospital stay, infection, SIRS, sepsis, multiple organ failure, culture of burn wounds, antibiotics used, result of treatment, lab tests, mortality rate and cause of death.

We divided the patients into the following age groups: under 15 years of age (children) and over 15 years (adults).

Multiple organ failure was defined as dysfunction of more than one organ system despite organ support. Inhalation injury was defined on the basis of exposure to smoke, burn in a closed space, presence of carbonaceous sputum, signs of airway obstruction, deterioration of Po2 in serial arterial blood gas tests and/or positive findings in bronchoscopy. Sepsis was defined as systemic inflammatory response to infection and positive blood culture. Wound cultures with more than 100,000 bacteria in each gram of tissue were considered positive. SIRS was defined as body temperature >38 or <36 C, heart rate > 90/minute, respiratory rate > 20/minute and white blood cell >12000 or <4000.

We applied multiple logistic regressions to identify mortality risk factors. Crude and adjusted odds ratios (OR) with 95% confidence intervals were reported. Statistical significance level was ($P < 0.05$) for univariable and multiple logistic regressions. We also calculated lethal area fifty percent (LA50 - the percentage of TBSA burned at which the probability of death for the patient is 50%). We calculated the Odds Ratio (OR) and Adjusted OR for each of the variables that can lead to the death of the patient.

Table II - Odds ratio and risk factors for death

Type of risk factor	Odds Ratio	p-Value
Inhalation injury	7.98	<0.0001
Age	1.03	<0.0001
TBSA	1.05	<0.0001
Female sex	1.88	0.001

Data and statistical analysis were performed with SPSS 19 software. P values less than 0.05% were considered significant.

Results

During the study, we saw 28,690 burn patients. 1721 of them were admitted according to ABA criteria for hospital admission. Male to female ratio was 1,75:1 (*Table I*). Mean +/- SD of age was 26.31 +/- 20.25. Age range was from 3 months to 93 years old. Median age was 25 (IQR 16 - 37). 28.3% of the patients were under 15 years old. 19.6% were under five, and 5.5% were over 65 years old.

About 33.6% were referred from other hospitals to major burn hospitals. TBSA burned ranged from 1 to 100%. Mean (SD) of TBSA was 16.48 (20.67). The most common cause of burn was flame (49.8%), followed by scald (35.7%). The cause of burn varied across the different age groups. In patients under 15 years old, scald was the most common cause, while in adults it was flame (*Table I*).

More than 92.7% of burn cases were accidental, 5.07% were suicidal, and about 1% were intentional. The median of TBSA burned in accidental cases and in occupational cases was similar, but in suicide cases it was much higher and the difference was significant ($p<0.001$).

Mean length of hospital stay was 14.41 days (range 0 - 64 days). In suicide cases it was twice as long. Probability of death was 8.4%.

We had 1721 cases and 514 were under 15 years old. Lethal Area 50 for total cases was 64.71 (CI 95%: 58.44-73.47). Lethal Area 50 for adults (patients aged 15 and older) was 62.31 (CI 95%: 56.57-70.02), and for children (patients aged less than 15) it was 72.52 (CI 95%: 61.01-100).

In uni-variable logistic models, females were more vulnerable to death than males (crude OR: 1.83, $P < 0.002$). In the multivariable model, this relationship remained significant (adjusted OR was 3.77, $P < 0.0001$) (*Tables II, III*). In the multivariable model, the adjusted OR of death for age was 1.05

Table III - Multiple logistic regression

Variable	Death probability %	Crude OR	p-value	Adjusted OR	p-value
Age	-	1.03	<0.0001	1.05	<0.0001
Gender					
Male	6.57	1	0.002	1	
Female	11.41	1.83		3.77	<0.0001
TBSA	-	1.09	<0.0001	1.09	<0.0001
Cause					
Other	1.61	1	<0.0001	1	0.189
Flame	15.01	10.81		2.08	
Inhalation injury					
No	2.86	1	<0.0001	1	0.01
Yes	19.81	8.39		1.71	

($P < 0.0001$) (*Table III*).

With an increase of 1% TBSA, probability of death from burns increased by 1.7%.

Crude OR of death due to flame burns was 10.81: when compared with burns caused by other substances, in the multiple logistic regression model this relationship was no longer statistically significant ($P = 0.189$) while the OR was 2.08.

Probability of death, crude and adjusted odds ratio of death among the patients is shown in *Table III*.

As we reported previously, we calculated the total costs for all patients in this period. The average total cost per patient was about $2810. Mean total cost per year was $2,417,595. Mean burn cost for every percent of TBSA was $162, while mean burn cost for hospital stay was $195 per day.

Discussion

Burn injuries are an important public health concern and are associated with high morbidity and mortality. In this paper, our aim was to identify mortality risk and predictive factors in burn injuries.

The risk of death among burn patients was 8.4% and LA50 for all of the patients was 64.7%. This means that half of the patients with approximately 65% TBSA burned would die.

LA50 differs in other reports: in 2003 in China, LA50 was reported to be 94% and 87% for full thickness burns.[11] In 2005, it was reported to be 80% in Taiwan and about 60% in the UK.[12,13]

There are three interesting reports from the UK. The first two papers showed that LA50 decreases with age, especially in patients over 65 years old, where it falls to 28%.[13,14] The third report stated that LA50 had not changed in 20 years.[15] In 2004, a report from the USA stated that an LA10 of 73% in burn patients fell to 50% if they had inhalation injury.[16] In a report from Kuwait, LA50 was 76.5% for adults and 41.8% for the elderly, similar to reports from the UK.[17] LA50 was 39% in a report from Africa,[18] which is much lower than our result. In the Czech Republic, it was reported that LA50 was 55% and that it decreased with age.[19]

It seems that more educational and preventive programs are needed in our country and in countries like the USA in order to achieve a better outcome for burn patients.

To the best of our knowledge, there is no paper that compares LA50 values for adults with those of children. Our study found that LA50 was 62.3% for adults and 72% for children. This means that children can better withstand the trauma of an equal-sized burn, and that their probability of survival is higher for the same percentage of TBSA burned.

Our findings also showed that female sex, age and larger burn size (TBSA) were the major risk factors for mortality in burn patients. There are two reports from Muller and Sharma stating that the probability of death was higher in females than in males, even after adjusting for TBSA,[20, 21] and the results of our study confirmed this.

Cause of burn did not influence mortality. Flame burn was a risk factor for mortality in univariable analysis, but was no longer significant after adjusting for TBSA. Other papers[22,23,24,25] also reported burn size and TBSA to be the main risk factors for death. Previously, it was reported that scald was the main cause of burns in children under 5 years old and flames the most common cause in older children. Our study confirmed this report, and the fact that cause of burn had no influence on outcome.[23,26,27]

As for intent, there was no significant relationship between intentional injury and outcome. Suicide cases had more extensive burns than other cases ($P < 0.0001$). However, in the multivariable model, when adjusting for burn size, there was no relationship between intention and death. As we reported previously, self-immolation is the most common method of suicide in our country. In this study, we noted that the proportion of suicide burn cases was relatively higher than in developed countries, and very similar to developing countries like India and Pakistan.[23,26,27,28,29,30,31] Moreover, women were up to three times more likely to commit suicide. In developed countries, however, suicide by burning is equally distributed between males and females.[32,33] Also, the rate of suicide is lower than in developing countries.[34,35]

In our study, probability of death was lower than in previous reports from our country, but still higher than in developed countries. This may be due to a high proportion of severe burn injuries and a higher incidence of suicide in our country. The more serious the injury, the greater the probability of death.

Mean TBSA in our study was 16.5 +/- 20 percent, while other reports stated it to be 18.5% in Africa and 14% in Spain. In Taiwan it was also 14%, but only 7% for burns covering more than 40% TBSA, and in a report from Salt Lake City the mean TBSA was 14.1% and LA50 was 81%.[18,14,12,7,16]

In the latter report, the total mean cost per patient was about $40,000 and LA50 was 81%. In a report from the UK,[13] the total mean cost was about $25,000 and LA50 was around 60%. In our centre, total mean cost was about $2810 and LA50 was about 65%, which tells us something about quality and cost-effectiveness of burn treatment in different countries.

Applying multivariable models is the best way to identify the major risk factors of death in burn patients. In our study we found burn size, age, inhalation injury and female sex to be the main risk factors. This information is very important for au-

thorities to develop proper infrastructure facilities and strengthen preventive and training programs for physicians, staff and patients to improve quality of care and survival rate. This study also showed that deep 3rd and 4th degree burns, chronic disease and concomitant disease, as well as cause of burn, had no relation to the outcome of the burn patients.

Our burn registry program was established to record and manage data on burn patients, and this is the main research priority of epidemiologic studies in our country. This program is a way to collect data on the death rate and causes of death in burn patients, as well as on therapeutic procedures and their outcome. It is useful for a uniform evaluation of burn centres, and will help policy makers to decide on the most appropriate services, and on preventive and training programs. It also helps to evaluate the main risk factors for mortality, identify vulnerable groups, and improve patient survival.

Conclusion

LA50 is higher in children than in adults. Cause of burn and intention had no influence on mortality. Burn size, female sex and age are the most significant predictors of mortality in burn patients. Suicide is more prevalent in our country, especially among women.

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